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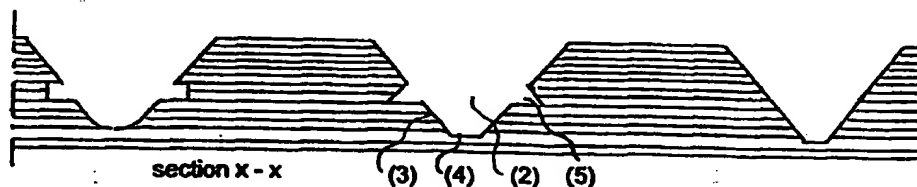
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(54) Title: **A METHOD OF TREATING LAMINATED OBJECTS OF PLASTICS DAMAGED HYDROLYSIS DELAMINATION OR SIMILAR**



(57) Abstract

A method to perform a repair of objects made of plastic laminate damaged by so-called osmosis, hydrolysis or similar and/or delamination and containing fluids and/or gases in the laminate layers. The improvement is mainly achieved in that a system of holes is arranged, consisting of a larger number of especially formed holes, spread over the surface of the object to be repaired, through which moisture and damaged material can be removed in a more effective and faster way even horizontally along the laminate fibre direction instead of only vertically through the superimposed, often undamaged layer forming a barrier. By means of the system of holes measurements might be carried out before the repair is made and a continuous control can be made during the repair, that the decontamination procedure has made in quality acceptable result before the object is restored. The holes in the system might after the application described previously be replenished with a hardened filler and be used as a reinforcing element comparable to spot welding to restore the repair object to its original strength. The reinforcing elements formed of a hardened filler are fixed by means of recesses arranged in the hole walls serving as holds for the hardened filler plugs, which have not to be moored in the superimposed layer.

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A METHOD OF TREATING LAMINATED OBJECTS OF PLASTICS DAMAGED  
BY HYDROLYSIS DELAMINATION OR SIMILAR

The present invention relates to a method to be preferably used to more effectively counteract a hydrolysis or an osmosis and/or a delamination, which to a larger or smaller extent might occur in almost any object made of a plastic laminate.

When a so called osmosis occurs to such an extent, that the devices are damaged, this entails in daily speech, that the objects are affected by bubonic plague, plastic plague, glass fibre plague or osmos or osmosis; the last designations have got a foothold both in the everyday Swedish and the international language. In this patent application, however, the expression hydrolysis will henceforth be used as a technically correct designation of these changes in a laminated plastic material.

Objects frequently exposed to hydrolysis are boats in laminated plastic materials. In an article in DAGENS NYHETER of October 13<sup>th</sup> 1993 (encl. 1) hydrolysis is described as a worldwide existing problem having affected and affecting many boats.

Therefore, the description will henceforth refer to the treatment of boats, even if the method is generally applicable.

The conventional way to dry and shield to repair hydrolysis damages might in accordance with the article be divided into the steps:

- to remove the bottom colour and any damaged laminate
- polishing
- drying
- providing a safety barrier

This conventional way comprises essential drawbacks, when operating from the laminate surface, sand blasting and machine grinding to be mentioned here :

A sandblasting supposed to be a proper method to remove both gel coating, the outer hard surface of a plastic hull and damaged material has here the drawback often and unnecessarily to destroy so much of the glass fibre reinforcement, that it actually should be replaced with a new one for not critically

damaging the hull. This is often not practised to keep the repair costs down and the resulting attenuation of the object is accepted as being unavoidable.

A further drawback of a sandblasting is that the method is restricted by environmental conditions and is, due to environmental reasons, prohibited in many places.

Machine grinding, e.g. by means of a disque, is another method of a conventional processing for removing gel coat and damaged material, but results in a packing of the surface with melt plastics due to heat development, thus delaying the drying of the hull and even damaging so much of the glass fibre reinforcement that the strength of the hull is reduced.

Common for both sandblasting and machine grinding is, that both only affect the surface of the hull and are not suitable for any deep-down repair of moisture and damaged hull material to effectively repair hydrolysis and delamination damages.

Only the drying is in a conventional method described to create problems of prevailing drying periods between two to six months, but even more.

The low quality of the conventional method is illustrated by the large amount of repeated damages. Especially aggravating is, that a repeated hydrolysis will not create as many blisters in the hull and is not as revealing as the first time hydrolysis. Thus, a repeated hydrolysis may occur and may spread unnoticed in a hull and weaken it, until the seaworthiness in a critical case is endangered.

An alternative to the conventional method achieving an increased deep action, a shortened drying period and a possible restoring of the repair object strength to the original level is described in the Swedish patent application 9203358-8 A *Method for treating plastic Objects*.

The method there described, here below called the hyab method, is based on the application of an already known drying equipment of the hyperabsorbing type, here below called hyab equipment.

The hyab equipment uses compressed air and LP-gas in combination and the drying medium consists of a dry, hot air flow passing at a high speed the surface of the object to be dried. This drying method is here below called hyab drying.

The hyab drying is based on the fact, that moisture is removed from an object in that its surface is cooled down by the moisture evaporation and the moisture situated deeper in the material is brought by means of the so-called Claw of the cold wall is forced to reach the surface cooled down during the drying/evaporation to be absorbed there by the drying air. Heat, however, is pushing moisture away. The enclosed comparison between hyab drying and the so-called flame drying illustrates the behaviour of moisture in relation to the temperature conditions.

The practical application of the technique described in the above mentioned Swedish patent application has demonstrated the desire for a restoration and a drying of laminates attacked by hydrolysis in the inner laminated layers and/or for a repair of delamination damages to find solutions further improving and accelerating these steps during the treatment.

With an increasing laminate thickness the problems augment to define the actual damages and to perform the repair itself as well. The time period tends to become embarrassingly high, when the hydrolysis substances and moisture must pass right through a thicker superimposed laminate layer.

There is a risque that acid hydrolysis residues will at depth over 6 to 7 mm remain undetected by the normally used instruments and create further hydrolysis and an absolute protection against a renewed moisture penetration is practically impossible to achieve.

Delaminations as a consequence of an hydrolysis or mechanical reasons must often be conventionally taken care of in that superimposed laminate layers are removed to be replaced with new laminate layers at a high cost.

It is practically impossible for an operator to detect by means of conventional instruments before the operation starts, how deep the damages are and to determine the time period and the costs for a repair. The only hitherto known and acceptably reliable method has been to drill out plugs with a diameter of 30 to 50 mm all through the laminate in places, where measuring tools indicate high values. Plugs to be analysed later.

The drawbacks of this is i.a. that the restoring of said drilled test holes requires a lamination on both sides of the

object, which can be extremely troublesome with so many compartments hard to reach from the inside without any extensive and expensive operations.

This and the fact, that big holes with straight walls do not contribute anything useful to the repair work, as is the case with the invention, results in that their number is kept at a minimum.

The purpose of the present invention is to solve all said problems and, moreover, to add further advantages to the treatment of objects damaged by hydrolysis and delamination.

The invention provides in a fast and effective way the possibility to detect damages caused by an hydrolysis even for laminate thicknesses, where a generally known measuring equipment cannot provide any reliable measuring tests. This purpose is according to the invention achieved by the characteristics specified in claim 1.

The invention has a larger range than the previously mentioned Swedish patent application, but is generally applicable independent of the repair method being used, either a conventional method or the hyab method.

By drilling a larger number of hyab holes according to the invention spread over the entire hull and these with another shape, i.d. not through holes, compared with the known testing, it is achieved

- reliable measuring tests,
- that the hole system might be used to render the restoration and the drying procedure more effective,
- that the split layers of the laminate being damaged are fixed to each other again in possibly injecting penetrating material, e.g. epoxi through the hyab holes, and
- that further fixation of the laminate layers to each other might be achieved in a procedure similar to welding.

In adapting the number and the design of the hyab holes to the prevailing requirements and to the actual laminate structure and thickness the restoring procedures can in an optimal way become simple.

An embodiment of the invention will be described here below with reference to six figures, in which

Figure 1 shows a view of a damaged plastic object with several hyab holes,

Figure 2 shows a cross section x-x through a damaged plastic object with drilled hyab holes in various shapes,

Figure 3 illustrates in a view of the plastic object the principle for how moisture and damaged material can be removed out of the material by blowing hot hyab air against drilled hyab holes to be accessible there and then be removed,

Figure 4 illustrates possible tracks for moisture, material and drying air movements for the method for connected layers,

Figure 5 illustrates a possible complementing track for moisture, material and drying air movements for heavy delaminations,

Figure 6 illustrates an alternative method and tools to provide recesses 5 in a hole wall 3.

The hyab holes 2 shown in figure 1 are drilled by means of a profile drill from the outside of the damaged laminate 1 in a suitably square distribution pattern adapted to the laminate 1. If the drilling tool is shaped so that the hole 2 is provided with a rounded or plane bottom surface 3, air pockets will be avoided during the restoring filling.

Conically shaped holes 2 shown in figure 2 provide the maximum possible exposed surface, on which a hyab drying can be applied and the state of each layer forming the laminate 1 can be controlled separately.

Figure 3 illustrates that it with the hyab method is possible to accelerate the passing of moisture and material in the *fibre direction* and thereby possibly accelerating the treatment of the laminate 1 provided with hyab holes. In using the hyab technique controlled heat and the physical fact that moisture avoids heat, described in the comparison between hyab drying and the so-called flame drying (appendix 1) any moisture in the laminate and damaged material can, if the air stream is directed against the surface, be forced to escape the heat towards a hole 2 situated further away, where the temperature is lower to be absorbed there and be removed by the passing hyab drying air.

When a laminate 1 prepared with holes 2 is dried by means of the hyab drying or by means of another drying procedure, moisture and hydrolysis products can in accordance with figure 4 be carried away along the fibres of the attacked layers out through the holes 2 instead of only being forced to pass directly through all layers on their way up to the surface. The restoration will thus be many times faster. By means of a simple test with litmus paper the operator can even control deep down, that all acid indeed has been extracted from the laminate.

In figure 5 the shown cross section of the drilled hyab holes 2 illustrates that the drying air stream for delaminations 3 comprising at least the distance between two holes 2 pass over the laminate 1 from hole to hole from the inside between the layers and the required drying is achieved without the need to remove undamaged outside laminate layers. The air stream can then itself lift apart the layers in a careful way, whereby an effective restoring and drying is achieved.

When the holes 2 in accordance with figure 2 are provided with slanting walls no air cushion effect will occur preventing the air stream to pass over a straight blind hole's walls and bottom.

Figure 7 shows an embodiment of a blind hole 2 adapted for a thicker laminate, where the outside portion of the holes 2 provide an angle of 0 degrees in relation to the centre line of the holes 2.

An embodiment of the holes 2 shown in figures 2 and 6 implies that they are either from the start or after the decontamination but before the restoring provided with one or several recesses 5 and guarantee that the plug, which will consist of a hardened filler filling the hole 2, is kept in place without fastening it especially with an on top of the hull surface applied laminate.

The hyab drying provides the hull simultaneously with a controlled heating and an injected thinly fluid, e.g. epoxy, is concurrently with the cooling and the contraction of the laminate pressed into all cavities and after the hardening restores the laminate to its original strength or better.

Before any tender a larger amount of test holes can be drilled, because the holes 2 are easy to restore, compared with already known methods with larger drilled holes. A higher safety is achieved for estimating the real extent of the damages providing an advantage both for the yard and the client.

The present invention is not limited to the embodiment described previously.

CLAIMS

1. A method for treating laminated plastic objects (1), e.g. damaged by an hydrolysis, delamination or similar in the laminate layers probably containing liquids and/or gases, characterized in that the damaged portion is drilled with several holes (2), the holes consisting of blind holes (2) with at least at their lower portion provided with a slanting wall (3), whereafter moisture and damaged material are removed by means of a technique known in the art and material can be supplied to restore the damaged plastic object (1) after a finished decontamination,

2. A method according to claim 1, characterized in that the blind holes (2) have a flat, rounded or slightly conical bottom face (4).

3. A method according to claim 1 or 2, characterized in that the blind holes (2) are provided with at least one recess (5) in the hole wall (3).

4. A method according to anyone of the claims 1 to 3, characterized in that the slanting wall (3) of the blind holes (2) provide an angle to the centre line of the blind holes (2) of between 30 and 60 degrees.

5. A method according to anyone of the claims 1 to 4, characterized in that the outside portion of the blind holes (2) for a thickness over 10 mm of the plastic object (1) form an angle of 0 degrees in relation to the centre line of the blind holes (2) down to 25 % of the thickness at the most of the plastic object (1).

6. A method according to anyone of the claims 1 to 5, characterized in that the diameter of the blind holes (2) on the outside of the plastic object is at least equal to the thickness of the plastic object (1).

7. A method according to anyone of the claims 1 to 6, characterized in that the diameter of the blind holes (2) on the outside of the plastic object is less than 2,5 times the thickness of the plastic object (1).

8. A method according to anyone of the claims 1 to 7, characterized in that the number and the distribution of the blind holes (2) are adapted to an optimal treatment.

9. A method according to anyone of the claims 1 to 8, characterized in that moisture and damaged materia are removed with the so-called hyperabsorption technique (hypo-technique).

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/00440

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B32B 35/00, B29C 73/02 // B63B 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B32B, B29C, B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, RM25

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SE 506310 C2 (CRETO (INTERNATIONAL) LTD.), 1 December 1997 (01.12.97), abstract, claims  -----	1-9

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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